6.3 Eastern Strait of Juan de Fuca

A. Assessment

1. Salmon Use

Chinook

This is part of the Eastern Strait of Juan de Fuca and Admiralty Inlet region, which includes two independent populations, both of which emanate from this sub-basin:

- Elwha
- Dungeness

a) Juvenile

- Juvenile Chinook salmon of all four life history types of the Dungeness and Elwha populations utilize this sub-basin for feeding and growth, refuge, physiological transition and as a migratory corridor (juvenile salmon functions).
- Larger juvenile Chinook salmon and older life history types from non-natal populations are often found to utilize habitats and landscape features in this sub-basin. We hypothesize that Chinook from all 22 populations utilize the sub-basin's nearshore as a migratory corridor (see Table 3-1 for the list of Puget Sound populations).

b) Adult

- Sub-adult and adult salmon from Puget Sound populations utilize habitats within this sub-basin as a passage corridor and grazing area. Other than the Dungeness and Elwha, Chinook are documented to use Morse Creek and other regions in the eastern Strait (Figure E-3.1)
- Adult salmon from far outside Puget Sound (e.g., Columbia River and Snake River ESU's) may utilize habitats within this sub-basin as a passage corridor and grazing area.

Other Listed Species (not comprehensively reviewed or assessed for this sub-basin)

- Chum salmon: Two natal populations (Jimmy Comelately, Salmon/Snow) of the Hood Canal/Eastern Strait of Juan de Fuca Summer chum ESU exist in this sub-basin. We hypothesize that all populations of Hood Canal/Eastern Strait of Juan de Fuca Summer chum utilize the sub-basin's nearshore as a migratory corridor. Historically, summer chum were documented to have used Johnson's Creek.
- Bull trout (anadromous): Occurs in two core areas (Elwha, Dungeness) in this sub-basin. The Elwha core area contains one identified local population, but additional populations may exist. The status is unknown for this core area, but few individuals exist in the Elwha population (USFWS 2004). The Dungeness core area contains two populations, of unknown status. Bull trout use has also been documented in Ennis Creek, Bell Creek, Seibert Creek, and Morse Creek.

2. Ecological and Landscape Conditions

Food Web, Ecological Conditions

Shaffer and Crain (2004) summarize ecological conditions in this sub-basin as follows:

> The north Olympic Peninsula has extensive shorelines that border the Strait of Juan de Fuca and the Pacific Ocean. More than 80% of the water from Puget Sound and the Strait of Georgia flows through the Strait of Juan de Fuca (Mackas and Harrison 1997). Direction of net water movement within the Strait of Juan de Fuca depends on depth. Net movement of cold oceanic deep water is to the east while net movement of fresher, warmer surface water is to the west (Mackas and Harrison 1997; Strickland 1983).
>
> The Strait of Juan de Fuca is a wind-dominated system, with currents changing dramatically within hours in response to both regional and larger scale oceanic winds (Hickey 1996; Strickland 1983). Strong seasonal storms contribute pulses of both freshwater and sediment to the Strait of Juan de Fuca. These pulses will form large lenses of very low salinity and very high turbidity within the nearshore zone along the majority of the shoreline of the Strait of Juan de Fuca. These lenses appear to occur primarily during winter and spring months. Due to deep oceanic water and strong wind and current mixing action, as well as seasonal strong contribution of riverine nutrients, the water of the main basin is well-mixed, cold, and nutrient-rich throughout the year (Mackas and Harrison 1997). This is in direct contrast to the shallow enclosed embayments of the Strait of Juan de Fuca, which may be seasonally stratified and, in some instances, nutrient-limited (Mackas and Harrison 1997).

The Elwha River dams and shoreline armoring are largely responsible for sediment starvation along the shoreline within the Elwha drift cell. As a result, the shorelines contain larger substrates and extensive kelp beds.

Forage fish use is highly variable, and surf smelt spawning appears to occur later in the summer than in other areas of Puget Sound, with egg mortality approaching 30% (Shaffer 2004). Forage fish spawn in lower rivers on the Olympic peninsula and have been shown to use kelp beds. Forage fish spawning habitat in the nearshore and riverine environments are extremely important.

Landscape Conditions

Shaffer and Crain (2004) describe nearshore as: "a critical component to marine ecosystems, and the nearshore Strait of Juan de Fuca is a critical component of a functioning Puget Sound ecosystem. It is the conduit for species migrating to and from inland marine waters of Puget Sound and British Columbia."

Continuity and connectivity of eelgrass and kelp beds are important to migrating juvenile and sub-adult salmon from all 22 populations of Chinook and the populations of Hood Canal/Eastern Strait of Juan de Fuca Summer chum

See Figures E-3.1 through E-3.5 in Appendix E for additional characterization of the landscape of this sub-basin.

Pocket Estuary Analysis (includes area west to Elwha River only)

We identified 22 pocket estuaries in this sub-basin: most are located at the southern terminus of Discovery Bay, Sequim Bay, Dungeness Bay and Port Angeles Harbor as seen in Figure E-3.4.

- Freshwater sources were observed in all but six of the pocket estuaries,
- Based on the assumptions listed in Appendix B, all three of the Chinook functions (feeding, osmoregulation and refuge) were estimated to occur in nine of the 22 pocket estuaries.
- Composite "scores" were generated for each pocket estuary based on likely Chinook functions and stressors observed during analyses. Seven pocket estuaries were estimated to be *properly functioning*. Eight pocket estuaries were estimated to be *not properly functioning*. The remaining pocket estuaries were recorded as *at risk*. (Fig. E-3.2)

Drift Cell Analysis

Unlike the pocket estuary analysis, drift cell function was considered for major drift cells west to Neah Bay with the Strait of Juan de Fuca. The action of wind-dominated waves on both bluff and deltaic sediments is a strong determining factor on beach structure. The Strait also provides a living laboratory of large-scale drift cell function that happens over shorter time periods than elsewhere in the Sound and so intensive monitoring of sediment transport as a result of restoration actions is very feasible here. The drift cell characterization for this sub-basin is presented in Appendix E, Figure E-3.5 and subsequent text. Littoral drift, feeder sources, deltaic processes, deposition, and recommendations for protection and restoration are discussed in Appendix E and highlights of recommendations are presented in Tables 6-6 and 6-7.

Threats/stressors

Loss and/or simplification of delta and delta wetlands

Comparison of historical wetland area and wetland area reported in Bortleson et al. (1980) revealed that for the Dungeness delta, the estimated area of subaerial wetlands did not change from historical to date of survey in 1980 (0.19 square miles). The estimated area of intertidal wetlands increased slightly from 2.28 to 2.32 square miles. Since the time of the Bortleson report in 1980, the Dungeness region has experienced rapid growth, and the estuary has been altered from historic conditions by conversion to agriculture, development, and altered sediment transport regimes.

Overall area (pertains to that portion of the Strait west to the Elwha River; only the drift cell analysis reflects the entire strait west to Neah Bay)

- Total area (deep-water plus nearshore) is 412,030 acres (643.8 square miles), the largest of all 11 sub-basins.
- Deep-water portion (marine waters landscape class) comprises 363,390 acres (567.8 square miles), or 88% of the total sub-basin area.

Nearshore area (except for information in the first two bullets, all information pertains the entire Strait, west to Neah Bay)

- Nearshore portion comprises 48,640 acres (76 square miles), or 12% of the total sub-basin area. As part of the nearshore, the Elwha and Dungeness estuaries (landscape class) are natal estuaries for the independent Chinook populations listed above, comprising 12.75 square miles (17%) of the total nearshore area within this sub-basin. (Fig. E-3.1)
- Nearshore area within this sub-basin is 12% of the nearshore area of the entire Puget Sound basin.
- Contains 217 miles of shoreline (beaches landscape class).
- The "key" bays (landscape class) identified in this sub-basin are Discovery Bay, Sequim Bay, Freshwater Bay, Crescent Bay, Clallam Bay, and Neah Bay.(Fig. E-3.1)
- 17 linear miles (8%) of the shoreline is designated as marine riparian (defined as the estimated area of length overhanging the intertidal zone).
- In this sub-basin, 34% of the shoreline (75 linear miles) has eelgrass (*Zostera marina* and *Z. japonica*); may be patchy or continuous.
- In this sub-basin, 44% of the shoreline (95 linear miles) has floating kelp; may be patchy or continuous. Also in this sub-basin, 74% of the shoreline (161 linear miles) has non-floating kelp; may be patchy or continuous. The kelp beds of the Strait of Juan de Fuca are the majority of Washington's coastal kelp resources.

Information is not available from the Bortleson (1980) report for the Elwha delta. The Elwha estuary and wetlands have been altered since construction of two dams, discussed below. The Elwha estuary was historically not large, but the size has decreased since construction of the two dams (Wunderlich et al, 1994).

Alteration of flows through major rivers

Two dams exist on the lower Elwha River. The lowermost dam, Elwha, was constructed in 1910 and both this and the Glines Canyon dam have significantly altered the nearshore and estuary due to a loss of sediment transport. An estimated 17.7 million cubic yards of clay, silt, sand, gravel and cobbles have accumulated behind both dams, and would be released upon dam removal scheduled to begin in 2007 (Elwha River Ecosystem Restoration Implementation, Final Environmental Impact Statement, 1996).

The Dungeness River system is impacted by water withdrawals. On the lower Dungeness River floodplain, tributaries and independent drainages have been diked, levied and channelized. Diking of channels has altered the flow of water in distributary channels.

Modification of shorelines by armoring, overwater structures and loss of riparian vegetation/LWD

In this sub-basin west to the Elwha River only, shoreline armoring occurs along 37 miles (27%) of the shoreline. (Fig. E-3.3) Over 16 miles of shoreline are classified as 100% armored. Nearly 99 miles are classified as 0% armored. In this sub-basin west to Neah Bay, the total number of overwater structures is 1,439, consisting of ramps (33), piers and docks (104), small slips (1,286) and large slips (16). These structures are observed in greater concentrations in Port Angeles, Sequim Bay and Discovery Bay. The railroad no longer operates on the Olympic peninsula, but the railroad grade is still present. Within 300 feet of shore railroad grades occur along 1.8 miles of Eastern Strait shoreline, along Discovery Bay, part of Sequim Bay, and a section of the Port Angeles shoreline.

Contamination of nearshore and marine resources

Non-point pollution via nutrient loading (as well as stormwater and industrial uses) is a significant concern in this sub-basin, and when combined with shoreline alterations in semi-enclosed embayments, macroalgae blooms (e.g., *Ulvoid* mats) can occur which can elicit changes to community structure.

Water quality impairments stressors in this sub-basin are mapped in Fig. E-3.3

Alteration of biological populations and communities

Two hatcheries exist on the lower Elwha River (Wunderlich et al, 1994). Specific hatchery reform recommendations for this region have been formulated by the Hatchery Scientific Review Group available at the following website.
http://www.lltk.org/pdf/HSRG_Recommendations_February_2002.pdf

Shellfish aquaculture occurs primarily within protected bays like Dungeness Bay, Sequim Bay and Discovery Bay.

Transformation of land cover and hydrologic function of small marine drainage via urbanization

Urbanization effects hydrologic function in 7 pocket estuaries within this sub-basin including Cassalery Creek, Morse Creek, Peabody Creek and Valley Creek which provide important sources of freshwater to the nearshore. See Figure E-3.4 for a list of pocket estuaries and stressors noted by review of oblique aerial photos.

Transformation of habitat types and features via colonization by invasive plants

In this sub-basin west to Neah Bay, *Spartina spp* are not found. Also, 2.3% of the shoreline (5 miles) contains *Sargassum muticum*, which may be patchy or continuous.

B. Evaluation

In this section we list goals and evaluate the level of realized function for natal and non-natal Chinook, summer chum, and bull trout. From this we then list each of the proposed protection and restoration actions for this sub-basin, and describe the benefits to natal Chinook, non-natal Chinook, and summer chum and bull trout (if any).

Goals for listed salmon and bull trout whose natal streams are in this sub-basin

a) Provide early marine support for all four life history types (fry migrants, delta fry, parr migrants, yearlings) of Elwha and Dungeness Chinook salmon populations.
b) Provide early marine support for the two natal populations of Hood Canal/Eastern Strait of Juan de Fuca Summer chum.
c) Provide marine support for sub-adult and adult anadromous bull trout populations within the two core areas in this sub-basin (Elwha, Dungeness).
d) Provide for connectivity of habitats; also, adequate prey resources, marine foraging areas, and migratory corridors for juvenile, sub-adult and adult Chinook, juvenile chum, and bull trout.
e) Provide early marine support for independent spawning aggregations occurring in this sub-basin.

Goal for listed salmon and bull trout whose natal streams are outside this sub-basin

a) Provide support for all neighboring Puget Sound populations (juveniles, sub-adults, and adults). All 22 populations of Chinook in Puget Sound, (and presumably all populations of Hood Canal/Eastern Strait of Juan de Fuca Summer chum) utilize nearshore and marine regions of this sub-basin as a migratory corridor.

Realized function for listed salmon and bull trout

Fry Migrant Chinook – Fry migrants from the Dungeness Chinook population are well supported by low energy shorelines, pocket estuaries and Sequim Bay although poor water quality (e.g., low dissolved oxygen, stratification) within Sequim Bay and Discovery Bay (Fig. E-3.1) could be limiting survival at some times of year due to *Ulvoid* blooms. The lack of sufficient low energy shoreline or functional pocket estuaries near the Elwha delta could be limiting support for this life history type (Fig. E-3.2). Fry migrants that use pocket estuaries near Port Angeles may be exposed to higher levels of toxic contaminants. Also, removal of the two Elwha River dams is expected to benefit this life history type.

Delta Fry Chinook – Current conditions for delta fry of the Elwha Chinook population river are diminished but expected to improve greatly as a result of new sedimentation following dam removal. Delta fry in the Dungeness are well supported. Poor water quality in semi-enclosed embayments may impact this life history type. Also, removal of the two Elwha River dams is expected to benefit this life history type. Loss and degradation of small estuaries and shallow

water areas has reduced the availability of prey and refuge as well as disrupted migration for this life history type.

Parr Migrant Chinook - Parr migrants emerging from Elwha and Dungeness rivers would be well supported by the diversity of habitat types along this shoreline, however, the high-energy nature of much of this shoreline suggests an added importance for pocket estuaries to act as refuge. Parr migrants will also be a major food source for larger sized life history types migrating toward the ocean from Puget Sound and South Georgia Basin. Poor water quality in semi-enclosed embayments may affect this life history type. Also, removal of the two Elwha River dams is expected to benefit this life history type.

Yearlings – Yearlings will find support in this sub-basin as they are similarly sized to other migrants passing through the region. Nearshore habitat west of the Elwha River is particularly useful because of the extensive kelp beds lining the shoreline. Poor water quality in semi-enclosed embayments may affect this life history type (as discussed above). Also, removal of the two Elwha River dams is expected to benefit this life history type.

Sub-adult and adult Chinook – Survival of sub-adult and adult Chinook salmon is dependent on the production and availability of forage fish species within nearshore regions of this sub-basin. In addition, marine vegetation such as eelgrass and kelp also play an important role in salmon survival. Poor water quality in semi-enclosed embayments may impact this life history type (as discussed above). Removal of the two Elwha River dams is expected to greatly benefit returning spawners, as an additional 70 miles of river will become available for spawning. Adequate adult escapement from the Straits fishery is also important.

Summer Chum – We hypothesize that small summer chum fry from the Dungeness and Elwha populations will encounter similar conditions as discussed in the fry migrant and delta fry Chinook sections, above. Marine vegetation is especially important to chum salmon because they leave estuarine regions for nearshore waters after a short period, and require adequate food supply such as copepods, as well as refuge opportunities. Many prey species are associated with marine vegetation such as eelgrass. Poor water quality in semi-enclosed embayments may impact this life history type (as discussed above). Also, removal of the two Elwha River dams is expected to benefit summer chum.

Bull Trout – The Strait of Juan de Fuca's estuaries and nearshore waters provides critical foraging, migration, and overwintering habitats for sub-adult and adult anadromous bull trout (USFWS 2004). In this region, these habitats are important for maintaining life history diversity and access to productive foraging regions (USFWS 2004). In addition to the Elwha and Dungeness core areas, bull trout have been shown to use other marine tributaries (e.g., Ennis Cr., Bell Cr., Morse Cr., and Siebert Cr.) for foraging and overwintering, possibly as "stepping stones" when moving through marine waters, as well as refuge from high water events (USFWS 2004). Poor water quality in semi-enclosed embayments may impact this life history type (as discussed above). Also, removal of the two Elwha River dams is expected to benefit bull trout.

All life history types in this sub-basin are at risk of non-support in the event of an oil spill since large volumes of crude oil are transported through this area to refineries at March Point and Cherry Point.

Table 6-6. Recommended Protection Actions for the Eastern Strait of Juan de Fuca

Protection Action	Benefit to Natal Chinook	Benefit to Other (non-natal) Chinook	Benefit to summer chum, bull trout, other fish
Protect pocket estuaries and shallow water/low velocity habitats from further degradation near the deltas (w/in 5 miles), but skew this protection area to the east per oceanographic currents	Early marine support of all 4 life history types of Elwha and Dungeness Chinook populations (feeding and growth, refuge, osmoregulatory, migration functions). Addresses all four VSP parameters	Support for neighboring Puget Sound populations (e.g., Hood Canal Chinook, larger juveniles from other populations, Fraser River populations). Functions addressed: feeding and growth, refuge, osmoregulatory, migration	Support for neighboring Hood Canal summer chum, anadromous bull trout and other species. Functions addressed: feeding and growth, refuge, osmoregulatory, migration
Protect all feeder bluffs	Sustained migratory functions, riparian food source, refuge for Elwha and Dungeness populations	Sustained migratory functions, riparian food source, refuge for Hood Canal Chinook populations	Sustained migratory functions, riparian food source, refuge for Hood Canal summer chum populations; refuge, feeding and growth functions for anadromous bull trout
Protect against catastrophic events (oil spills)	Sustained feeding, growth, refuge, migration, osmoregulation for Elwha & Dungeness populations	Sustained feeding, migration and growth for Hood Canal Chinook, migration for other populations	Sustained feeding, growth, refuge, migration, osmoregulation for anadromous bull trout; feeding and migration for summer chum.
Protect functioning drift cells that support eelgrass bands and depositional features along the shoreline of Discovery Bay to Fort Worden (shoreline protection targets 19-23 in Fig. E-3.5), all west Whidbey Island shorelines within the sub-basin and between Port Angeles and Agnew (shoreline protection target 11).	Sustained feeding, growth and migration for Elwha and Dungeness populations	Sustained feeding, growth and migration of Hood Canal and other Puget Sound populations	Sustained feeding, growth and migration for summer chum, anadromous bull trout and other species.
Aggressively protect Eagle Creek, Paradise	Sustained feeding, growth, refuge and	Sustained feeding and growth for Hood Canal	Sustained feeding, growth, refuge and

Protection Action	**Benefit to Natal Chinook**	**Benefit to Other (non-natal) Chinook**	**Benefit to summer chum, bull trout, other fish**
Cove and Bell Creek lagoon as properly functioning pocket estuaries within the sub-basin	osmoregulation for Elwha and Dungeness populations	and other populations	osmoregulation for anadromous bull trout; feeding and refuge for summer chum
Protect delivery of upland sediment sources to the nearshore from Shoreline protection targets 1a,b,c, 2,5,7, 10, 12-15 and 24 in Fig. E-3.5	Sustained feeding, growth, refuge and osmoregulation functions for Elwha and Dungeness populations	Sustained feeding, refuge and migration functions for all populations	Sustained feeding, growth, osmoregulation and refuge for anadromous bull trout; feeding, migration and refuge for summer chum and other species

Table 6-7. Recommended Improvement Actions for the Eastern Strait of Juan de Fuca

Improvement Action	Benefit to natal Chinook	Benefit to other (non-natal) Chinook	Benefit to summer chum, bull trout, other fish
Consider and or continue (expand) wastewater reclamation and reuse retrofits for Port Townsend, Sequim (model for success) and Port Angeles wastewater discharges	Improved feeding and growth, osmoregulation functions for Elwha and Dungeness populations		
Restore pocket estuaries and shallow water/low velocity habitats near the deltas (w/in 5 miles), but skew this protection area to the east per oceanographic currents	Improved feeding, growth, osmoregulation and refuge functions for Elwha and Dungeness populations	Improved feeding, migratory and refuge functions for Hood Canal and other populations	Improved feeding, growth, osmoregulatory and refuge functions for anadromous bull trout; feeding and refuge, and migratory functions for summer chum and other species
Incorporate beach nourishment from Port Angeles landfill to Ediz Hook (special restoration target 8) as elements of the efforts to restore the Elwha delta and adjacent shoreline	Improved migratory feeding and refuge functions for Dungeness population	Improved migratory functions for all Puget Sound populations	Improved migratory, feeding and refuge functions for anadromous bull trout; migratory functions for summer chum and other species
Consider restoration of functions in Maynard, Blyn, Glenn Creek and Morse Creek pocket estuaries currently at risk of degradation	Improved feeding, growth, refuge and osmoregulatory functions for Elwha and Dungeness populations	Improved feeding and migratory functions for other Puget Sound populations	Improved feeding, growth, osmoregulatory and refuge functions for anadromous bull trout; feeding and migratory functions for summer chum and other species
Restore estuarine delta structure and functions as a result of Elwha dams removal and re-establishment of low elevation channel migration zones (Shoreline restoration target 7). This projects is regionally significant	Improves all functions for all life history types of Elwha population. Feeding, growth osmo regulation and refuge functions for Dungeness population fry migrants	Improves feeding, migration and refuge functions for all Puget Sound populations	Improves feeding, growth, osmoregulation functions for anadromous bull trout; feeding, migratory and refuge functions for summer chum and other species